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INDIA RUBBER

ITS MANUFACTURE AND USE.

With Illustrations.

BY

GEORGE N. NISSENSON.

AUTHOR OF

"PRACTICAL TREATISE ON INJECTORS."

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NEW YORK, U. S. A.

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PREFACE.

FOR the past fifty years India Rubber has become an object of great interest since the art of vulcanization has been discovered and improved by Chas. Goodyear of New York, most valuable discovery connected with this manufacture, and at the present time India Rubber occupies such an important position in the economy of modern arts and manufactures, that were it suddenly withdrawn from circulation many minor industries would in consequence cease to exist, while numerous large and important branches of handicraft would languish until arrangements would be made to adapt their operation to the altered circumstances.

The procuring of raw Rubber, and the art of its vulcanization and also the manufacture of articles of India Rubber for so many various and useful applications are of great interest, not only to the Mechanical profession, but also to every intelligent man, and therefore the need of a practical and accessible work on this subject is greatly felt at present.

In offering the following pages to the consideration of the Mechanical Skill and Intelligence of the United States, I trust that the book, such as it is, may answer to its title and recompense the labor of

THE AUTHOR.

New York:
176 East 108th Street.

CONTENTS.

INDIA RUBBER (Caoutchouc).

The earliest rumors of the existence of Caoutchouc, best known to us as *India Rubber*, reached Europe nearly 500 years ago, the first visit of Columbus to Hayti having brought to light the fact that the natives of that Island were in the habit of making play balls of elastic gum. In 1736, La Condamine first discovered that the substance is a dried milky juice of a tree which the Indians on the coast of the river Amazon called Caout-Chou, and from which they have been making waterproof fabrics and other articles.

Among the first of the important patents regarding the utilization of Caoutchouc is that granted in 1823 to Chas. Mackintosh of England for dissolving the substance in coal oil or coal naphtha and the use of this solution as a waterproof agent. About the same time elastic webbing was first made with threads cut from the raw rubber, afterwards other minor applications of rubber to the industrial arts were adapted from time to time.

The properties of India Rubber are: it is impermeable, tenacious and elastic, and these are so widely different from those of most other substances that it became an object of very great interest as soon as it made its appearance in the civilized world, and its industrial importance has rapidly increased as the knowledge of its remarkable characteristics and manifold applicability has become most extended.

It is, however, during the last fifty years that India Rubber has enjoyed its greatest triumphs as an industrial agent; that is to say, since the art of vulcanization* was discovered and improved by Chas. Goodyear of New York. This discovery proved both curious and valuable because it altered the rubber to such an extent as to render it capable of resisting both heat and cold.

Caoutchouc or India Rubber is a concrete milky juice produced by various trees. The trees which yield the largest supply of the best quality of rubber consist of various species of Hevea, which flourish in the Northern districts of South America, especially in the province of Para, about 1800 miles above the mouth of the Amazon, which is crowded to an extraordinary extent with heveas.

The abundance of the India Rubber trees in Para may be judged by the fact that this province alone exports about 18,000,000 pounds of rubber annually, more than half of which is sent to England. Among the heveas most productive of rubber may be mentioned the Hevea Brazilience, which flourishes in Para and yields some of the finest rubber, often attaining a height of 60 to 75 feet and having a diameter of nearly 3 feet.

The Hevea Guianensis is a similarly magnificent tree, and the Hevea Spruceana is a smaller tree which grows almost exclusively in the province of Para.

The figure 1 represents the flowers and foliage of Hevea Guianensis.

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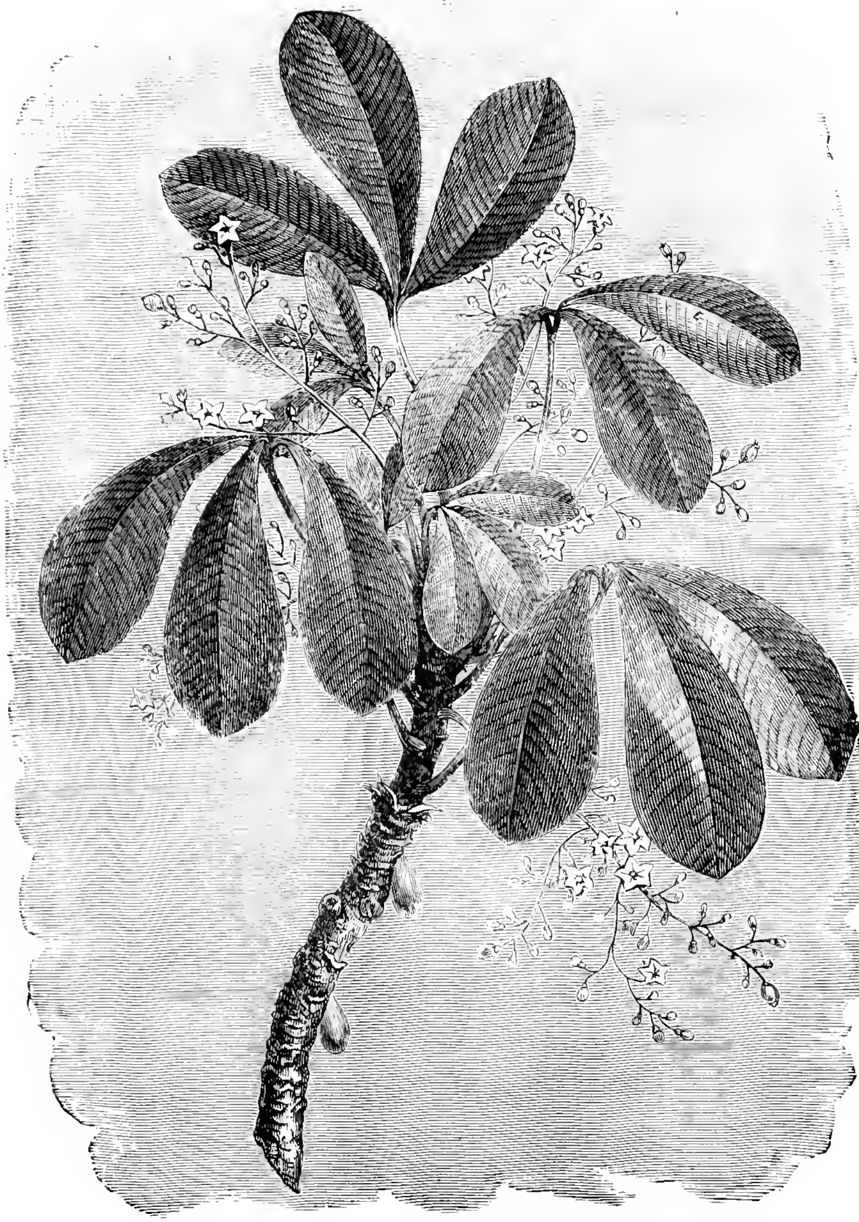
* Vulcanization is the art or process of imparting new properties to rubber by causing it to combine with sulphur through the agency of a high temperature. It will be explained hereafter.



HEVEA GUIANENSIS. FIG. I.

As a rubber producing tree the Ficus Elastica stands next in importance to the heveas. The Ficus Elastica, represented on the fig. 2, grows abundantly in India and East Indian Islands, one district in Assam occupying a space of about 160 square miles being said to contain 43 thousand trees, many of them attaining a height of 100 feet. The juice of the Ficus Elastica contains very much less rubber than that of the American trees, the proportion very often falling as low as 10 per cent. of the juice.

A vine-like plant, the Urccola Elastica, which grows abundantly in Madagascar, Borneo, Singapore and other places yields a considerable amount of rubber, which seems to be well adapted to some classes of work. The vine is rough and knotty and about as thick as a man's arm, and it grows to a length of fully 200 feet. The rubber taken from the top of the vine is of better quality than that which comes from the bottom. The juice is procured from a transverse incision in the large root. The incision penetrates the wood, but the flow of juice is from the bark alone. Under the incision a hole is scooped in the earth in which a leaf is folded like a cup, or else a tin vessel is suspended, into which the thin and nearly colorless juice runs. The juice flows rapidly at first but diminishes in a few moments, and in two or three days a layer of rubber is formed over the wound and the flowing ceases. After the juice has been collected the moisture is evaporated and the rubber smoke-cured in the following original way: A sort of Bat is dipped into a pail filled with the juice, and then held in the smoke of a fire, as shown in the fig. 3, and this process is continued until the rubber on the Bat

FICUS ELASTICA. FIG. 2.

becomes about an inch thick, when a cut on one end allows the Bat to be removed, and the rubber is hung up to be still further dried.

The method of curing makes it always easy to distin-

Fig. 3.

guish Para rubber, for the fire over which it is smoked is made of wild nuts, which besides giving a very dense smoke, imparts to the rubber a certain fragrant aromatic odor that is readily detected.

The juice can also be imported in the same liquid state as procured from the tree, without losing any of

FIG. 4.

its properties, if the following method be employed: It must be strained through a cloth into glass vessels or tin cans, and then for every pound of juice one ounce of

concentrated caustic ammoniak must be added and the mixture well stirred. This must be done before the juice becomes oxydized by the constant action of the air.

The milky juice of Para rubber trees has approximately the following composition:

Rubber (or Caoutchouc), ...	33
Albuminous, extractive and saline matters, .	13
Water, ...	54
Total,	100 parts.

Caoutchouc like many other substances contains nothing but carbon and hydrogen, but its properties differ very widely from those of other hydrocarbons almost identical in composition. It has been found to contain in 100 parts 12.5 hydrogen and 87.5 carbon, the specific gravity being 0.95. The rubber is soft and elastic at the ordinary temperature, and is very firm and unexpansive below O°, but becomes converted into a variety of volatic hydrocarbon at the temperature somewhat above 200° C. Fresh cut surfaces of rubber adhere very strongly when brought into contact.

It possesses in the highest degree the property of expanding or swelling in certain fluids, and in consequence of that becomes dissolvable in many substances, to which, under other conditions, it is entirely indifferent. In many solvents, for instance, in mixtures of alcohol and bisulphide of carbon, Caoutchouc swells up to 30 times its original volume. The residue of Caoutchouc, after the treatment with the solvent, appears, when examined with a microscope, like a net, having quite wide meshes, which contract, though, considerably in drying out. This shows that Caoutchouc consists of

an insoluble base with minute pores containing the soluble parts, which resemble vegetable glue or mucein in being distended by absorbing fluid it is in contact with, and thus facilitating the action of the solvent.

The elasticity of Caoutchouc depends upon the quantity of soluble matter it contains.

VULCANIZATION.

The Vulcanization is the most important of all the operations in the manufacture of rubber, and one without which all the other steps would have been worthless. It consists in subjecting the rubber, mixed with its proper proportion of sulphur and other chemical substances, such as oxides of lead, zinc, iron, etc., to a certain degree of heat for a special time, the amount of heat and the time necessary varying according to the mixture, the kind of rubber and the article to be manufactured. Whatever foreign substances may enter into the compound it is the sulphur, which, by making a chemical affinity with the rubber, effects the Vulcanization.

The following is a description of the process: the raw masses of rubber are first placed in a large tank of hot water and allowed to soak until the exterior is partially softened and the impurities on the surface, such as dust, bark, leaves, etc., always mixed with it are removed. By this process the rubber loses a substantial portion of its weight, from 12 to 15 per cent. in the best qualities, to as high as 40 per cent. in the cheapest kinds. The rubber is then cut into convenient pieces by means of a large knife. In the large rubber shops a circular knife is used for that purpose, between 3 and 4 feet in diameter, which revolves with great speed, cutting the tough mass as easily as if it was clay. These slabs are then taken to a machine called *Crackers*, having large

deeply grooved cast iron cylinders, which revolve in pairs, and stretch the rubber in the form of a rough sheet with a broken surface. A stream of water is kept flowing on the rubber during that operation and continued until all extraneous substances have been removed and nothing but pure rubber remains.

These sheets then go to the steam heated drying room (before the next so-called mixing operation can be undertaken), where it requires from one to four months to thoroughly evaporate all the moisture they contain; unless this is done the rubber would be fit only for the inferior kinds of goods.

The operation of mixing consists in passing the rough sheets, which preparation has been previously described, between smooth iron rollers heated from the inside to a temperature of about 100° F., and gradually feeding in the sulphur and the other substances to be incorporated. The rollers run at different speeds, and the sheets are continually passed and repassed between them until the mixture has been brought into a state more soft and less tenacious and elastic than the ordinary India Rubber, so that it may be compressed or moulded into any desired shape by the machinery employed. It is passed between the rollers, beginning with those which are somewhat apart and gradually contracting them each time after the rubber has passed through, until they produce the thickness required. If any colouring matter is required, it may be mixed in during this operation, and the amount necessary for this purpose is always slight.

Sulphur gives great elasticity to rubber, and is the vulcanizing agent, and must form a part of all the mixtures used. It is impossible to determine the exact

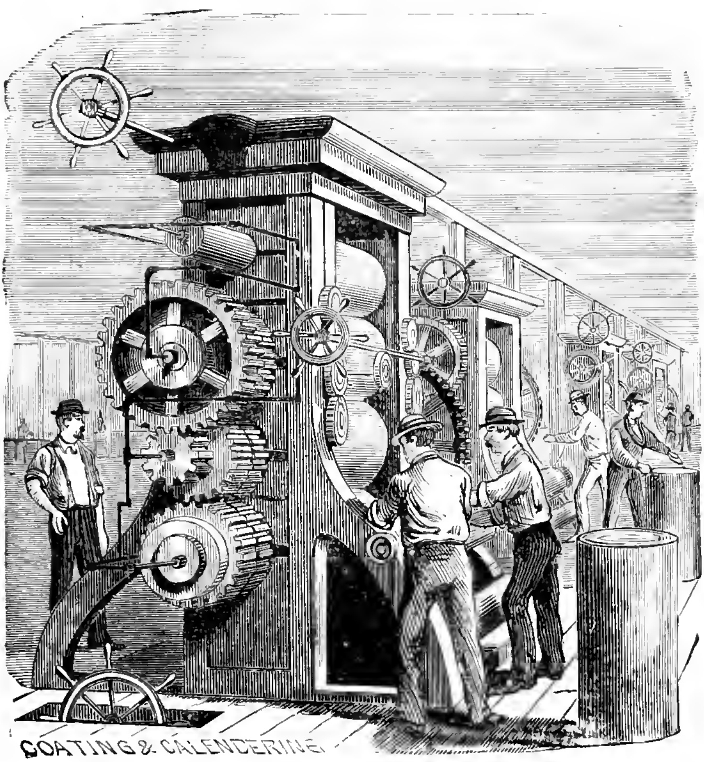
proportion of sulphur to be mixed in, as every manufacturer mixes it differently. Mr. Nickel's patent consists in kneading together 10 pounds of sulphur and 60 pounds of rubber. About 10 per cent. of the weight of the rubber is generally taken as a common proportion. The quantity of sulphur and other chemical substances is generally determined according to the quality of rubber or goods it is desired to produce.

The substances to be worked into the rubber are accurately weighed, a quantity of mixture for a fixed quantity of rubber, and care must be taken that the sulphur should be free from acid, and also from the moisture which sulphur always takes up so rapidly on exposure to the atmosphere. After the mixing process has been thoroughly completed the rubber is ready to receive the shaping required to produce the required article, either by being pressed into moulds, or passed between heavy rollers to form it into thick sheets; or through powerful calendering machines to spread it on cloth that is now in general use for such purposes.

The Calendering machine or Calender consists of a cast iron frame and cast iron smooth cylinders which are heated from the inside. As a different degree of heat is required for each kind of goods the temperature can be regulated by means of steam and water valves, through which steam and water enter into the cylinders. The upper roller or cylinder and the lower one can be raised or lowered by means of the gearing having hand wheels. The centers are for the mandrel or roller around which the cloth to be made waterproof is rolled.

The rubber is first worked to a perfect uniformity and thickness by the upper and middle rollers of the Calen-

der, the uniformity of the whole mass being ascertained by cutting a piece and holding it up to the light. If there are any granular particles to be seen the operation must be resumed until they disappear, and by gradually closing the rollers at the time of passing through, a sheet



CALENDERING MACHINE. FIG. 5.

of the required thickness, say from 1-16th of an inch and less will be formed, and being in contact with the cloth or fabric is pressed upon it.

The fabric intended to be made waterproof must be

rolled round a wooden mandrel having iron centers and placed in the center pieces of the Calender. The other end of the fabric is brought up and passed through the lower and middle cylinders of the Calender, and the softened sheet or film of rubber which has already been worked out to the required thickness is passed down on the fabric and remains on it. After the fabric has been drawn through the cylinders it passes over wooden rollers to the place where it is rolled up on a wooden roller. To prevent the adhesion of the fresh rubber film while rolled up some powdered soapstone is placed between the rollers and the fabric, thus covering the whole surface while passing to the roller to be rolled up.

The waterproof fabric is then folded in lengths upon a metallic plate or platform resting on four or more small wheels running on a track, and is discharged into a large empty steam boiler, arranged with thermometers for the purpose of accurately gauging the temperature, where it is exposed to the action of steam of the temperature of about 250° F. for a few hours, during which the rubber film becomes dry and firmly attached to the fabric.

CAOUTCHOUC THREADS.

On account of their elasticity and tenacity they are extensively used for the manufacture of elastic tissues, from which elastic webbing for shoes, braces, garters etc. are made. There are different methods of manufacturing them, but the elasticity of threads and their toughness depend principally on the raw material used. When cut out from caoutchouc plates they come with a square section. The plate must be fed to the knife of the cutting machine continuously, so as to obtain an unbroken thread, and a stream of water should fall on the knife steadily so as to prevent the caoutchouc from sticking to it. The round threads, on the contrary, are made from prepared caoutchouc, which has been changed into a plastic dough by treating it with proper solvents, and this dough is then pressed through a metal plate having circular holes, in the same way as vermicelli is made.

LIST OF ARTICLES MANUFACTURED OF INDIA RUBBER AND THE MODE OF THEIR MANUFACTURE.

Wearing Appliances: Clothing, Shoes and Boots, Hats, Caps, Leggings, Gloves, Umbrellas, Etc., Etc.

The above mentioned articles are made of the waterproof fabric (for description see page 17). In making shoes and boots the rubber sheets are subjected to the printing process. They are fed through steel cylinders of the Calender, on the face of which is engraved the pattern for sole, heel and upper desired to be produced. The waterproof fabric as well as the rubber sheets are taken to the cutting room, where the different parts are cut out and then sent to their respective departments, where they are put together in a fashion similar to that of other clothing and shoes, except that the parts are all put together by rubber cement, a liquid substance of rubber. After the parts of the articles have been put together they are placed in the vulcanizing boiler, whose description is on page 18, where they are subjected to a steam pressure of about 250° F. Some of the articles are also varnished to give them a bright finish, and dried, after which they are ready for sale.

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* Many of the articles are formed of pure vulcanized rubber, and others prepared with various pigments according to the required colour, quality or intended application of the article.

CEMENTS.

The rubber liquid or cement is made of vulcanized rubber soaked in Benzine and Turpentine Oil in equal proportions, and subjected to a stirring process for several hours. By the action of the two liquids on the rubber it becomes converted into a liquid, adhesive, sticky clay.

For Vulcanized Caoutchouc take:

Stockholm Pitch, ...	3 parts.
American Rosin, ...	3 "
Oil of Turpentine, ...	8 "
Caoutchouc, ...	6 "
Petroleum, ...	12 "

While heated, the mixture must be stirred. Should it be too thick for certain purposes, add more oil of turpentine. The surfaces to be joined together should be roughened by rubbing them with emery or pumice stone before the cement is applied.

For Glass take:

Caoutchouc, ...	12 parts.
Chloroform, ...	500 "
Mastic, ...	120 "

When applied to glass, this cement adheres at once, and possesses a high degree of elasticity. For Rubber Shoes make a solution of 10 parts of caoutchouc in 280 parts of chloroform by letting them stand in a bottle till the caoutchouc is entirely dissolved. Prepare another mixture by melting 10 parts of caoutchouc with 4 parts of

colophony. Add turpentine 2 parts and dilute with 40 parts of Oil of Turpentine. Pour the two solutions together.

Caoutchouc Glue for damp walls: This glue will prevent the falling off of painters' work, or the puffing up and becoming stained of the wall paper, when dampness comes through. It is made of

Caoutchouc,	10 parts.
Whiting,	10 "
Oil of Turpentine,	20 "
Bisulphide of Carbon,	10 "
Colophony,	5 "
Asphaltum,	5 "

These ingredients are put in a bottle and closed air-tight. The bottle must be kept in a warm place until every solid substance in it is dissolved. Occasional shaking, as a matter of course, will hasten the process of dissolution. Paper will adhere very tightly to it, and the wall will always remain dry after this glue has been applied to it with a flat brush.

Marine glue consists of a solution of one part of Caoutchouc in twelve parts of rectified petroleum, which are combined by heating and stirring with 6 parts of shellac or asphaltum. Marine glue will stick to wood and metal, and should be used hot.

PLAY BALLS.

Like many other India Rubber articles Play Balls are pressed from vulcanized Caoutchouc in suitable metallic moulds or forms and made in two or more pieces, which are joined together by a solution of Caoutchouc. But there is an important difference between the making of Play Balls and the production of dolls, toys and other ornamental figures so extensively used in our days. While in the case of the latter the air, enclosed in the hollow of such figures, must be removed, as it would otherwise expand during the burning process and burst the object, the former, that is the Balls, must be filled with compressed air by a special apparatus to give them necessary elasticity. A small condensing air-pump used for that has a fine needle attached to the end of the pipe condensing the air, and penetrating into the interior of the Ball. At the time of withdrawing the needle the hole is closed with some vulcanite matter.

TOY BALLOONS.

They are made from a clear solution of caoutchouc. A glass balloon serves as a form. A certain quantity of this solution is poured into it and distributed over its entire inner surface by swinging it to and fro, and the excess of solution is then allowed to run out. When nothing more drops out of the glass balloon, it is turned with the opening up and air is blown into the interior for the purpose of accelerating the evaporation of the solvent. In order to detach the balloon from the glass, to which it adheres quite tenaciously, it is necessary to loosen carefully the lower edge from the glass and blow some air between the film and the glass. After the thin caoutchouc film becomes separated from the glass, it has a form of an empty bag and can be easily pulled out through the open neck of the glass balloon.

MECHANICAL APPLIANCES.

Belting, Hose, Emery Wheels, Brose Pipes, Valves, Discs, Steam Packing, Buffer and Bearing Springs, Wringer Rollers, Wheel Tires, Etc., Etc.

Machine Belting. From a composition consisting of gutta-percha, caoutchouc, sulphur and sulphide of antimony, and possessing great tenacity, solidity and elasticity are manufactured belts used for transmitting power and for driving machinery. Their first cost is greater than that of genuine leather, but in the end they are cheaper, because they can be easily repaired. Bands are rolled from the mass, obtained from the above mixture, until they are entirely homogeneous. When the thickness of the band nearly approaches that of the belt required the temperature must be lowered so much, that the band can be forced through between rollers only at the expense of great power, to make the mass as compact as possible. The edges of the belt are then trimmed, and it is covered with linen cloth on one side before it is wound together. This precaution is necessary, as during the burning process, to which the belt has to be subjected before it is ready for use, the mass would fuse together, the temperature being raised for thick belts as high as 320° F.

The fabric used for that purpose is heavy cotton duck, such as is used for sails for ships. This duck, combined with the rubber by running through the

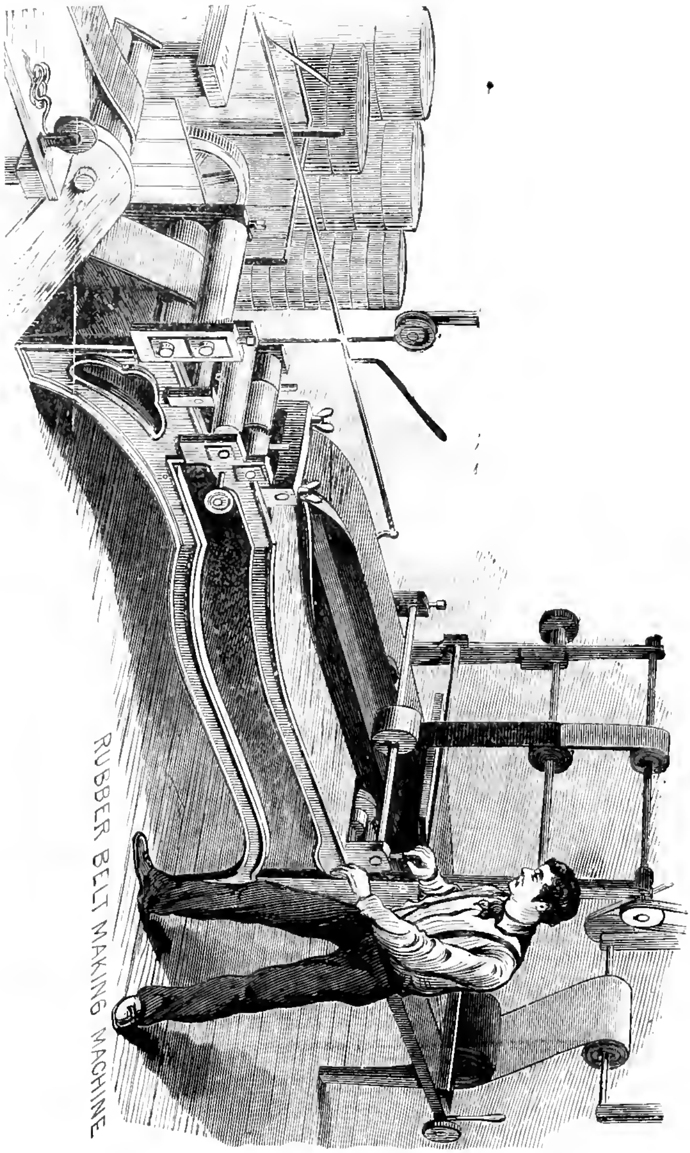


Fig. 6.

RUBBER BELT MAKING MACHINE

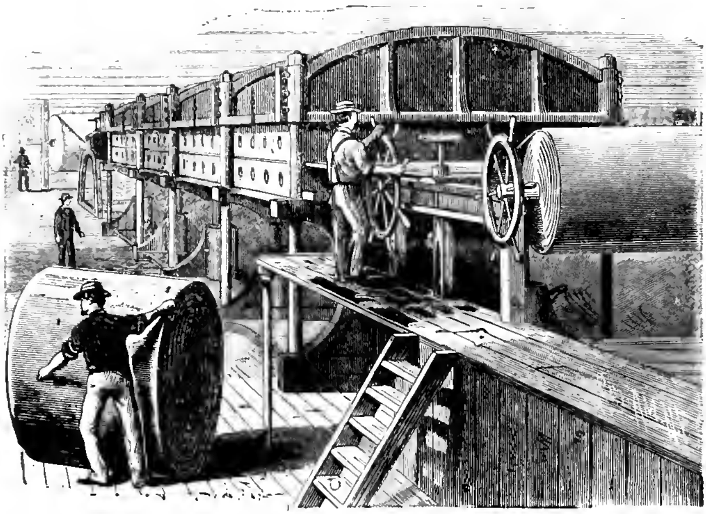
calender, is taken to a large department, where this branch of business is carried on, and unrolled upon tables 100 feet long, where the workmen cut it accurately to the required width.

One strip is cut so that folded it will make the width of belt, and another so that the wide strip will just fold over its edges and meet in the middle, which makes a three-ply belt. In this way the strips are passed between a series of powerful rollers, the temperature of which is evenly regulated, as in all other operations; the folding over at the sides makes an even and perfectly uniform half-round edge, and at the middle, where the edges of the outside strip come together, a narrow ribbon of rubber is fed to cover exactly the line of meeting.

In this way the entire outside of the belt is pressed by the heated rollers into an even, regular surface, each different kind of belt showing the same form and width for any number of feet, and presenting none of the irregularities in surface and thickness so often seen in leather belting, where copper rivets are plentifully used, and where the substance of the hide varies so greatly. As the rubber surfaces, before being vulcanized, would stick together, they are rolled up with a thickness of duck between, and the belt-making machine represented in fig. 6 has an attachment which takes up this fabric as the machine is fed.

Lately there has been introduced by the New York Belting and Packing Co. an improvement of especial importance in the manufacture of belting, by which the stretch can be thoroughly taken out of the largest sized belt by the aid of the immense hydraulic press represented in fig. 7.

The press, which weighs 85,000 pounds, will take a belt 6 feet wide and 15 feet long at one time, the steam is then let into the bed and platen so that the temperature



THE GREAT HYDRAULIC PRESS.
FIG. 7.

can be readily regulated; the platen is stationary and the bed is lifted by hydraulic pressure. The most novel feature of this great press, however, is that it is arranged with appliances at each end for stretching the belts, so that, while the belt is under the full tension of the heaviest strain it may be desired to put upon it, it may, at the same time, be compressed between both plates, and thus its fibres be set as firmly as in a bar of steel.

HOSE MAKING.

In making rubber hose, special care is taken in the first place in the selection of the best kinds of raw rubber for the particular description of goods to be manufactured, different mixtures being used, and the treatment varying in all the processes in order to obtain the exact condition and temper which will allow the rubber to be applied to the duck in the most favorable manner, and incorporated with the duck, so as to give the greatest amount of strength. The lengths and widths required for making each piece of hose are cut from long strips previously made ready in the calendering machine, and wrapped around long cylinders or mandrels, not tightly, but so that the freshly cut edges of the rubber will just meet. The rubber is then in such condition that, when the edges are pressed together, they unite so firmly as to hold with great tenacity, but to make the joint more firm, and of equal strength with the other portions, a thin ribbon of rubber is pressed against it, and then the mandrel or cylinder is revolved against the other cylinder, where the powerful pressure and the requisite degree of heat makes the entire section of fabric which has been fitted around it firm and compact.

This mandrel remains in each length of hose until the subsequent vulcanizing process has been completed; but to prevent the rubber sticking to it, the latter is coated with a powder such as soapstone or steatite.

When hose is made over brass or galvanized iron wire, or the latter is entirely imbedded therein, so that only a smooth rubber surface shall be presented outside and inside, this is effected by working the different layers successively, and then, as in other kinds of hose, subjecting each to powerful pressure by heated rollers before vulcanizing.

Although the materials used are somewhat different, and the working varies accordingly, this is substantially the way in which all kinds of hose are made from that of half an inch in diameter to that which is ten inches—from the common garden hose to that made for the steam fire engine, which will stand a pressure of over 400 pounds to the square inch.

Tube making covers the production of a great variety of goods, and tubes are made either of pure rubber or with a cloth insertion. Their manufacture proceeds on substantially the same principles as hose making, except that from their small diameter they are, after being formed on the mandrel, rolled and finished for the vulcanizing by hand.

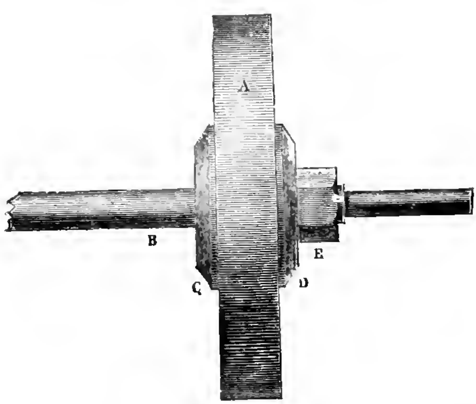
EMERY WHEELS.

Engravings 8 and 9 represent front and side view of a solid vulcanite emery wheel for grinding and polishing metals, and these wheels have been adapted in hundreds of the manufacturing establishments throughout this country and in Europe. Its general adaptability has enabled it to drive out the grindstone to a great extent in the manufacture of files, and it has greatly reduced the amount of work in which lathe tools were formerly used, so that it is now generally employed by workers in wrought, cast and chilled iron, hardened steel and

SOLID WHEEL—MOUNTED.

12 IN. DIAMETER; 2 IN. WIDE.

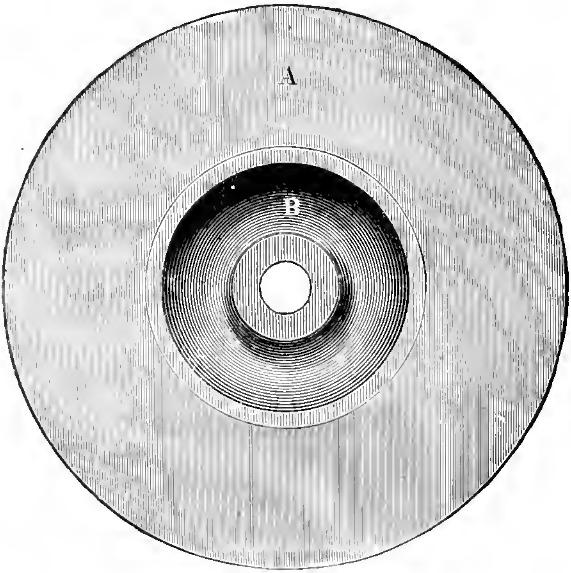
FRONT VIEW.



A, Emery Vulcanite Wheel; B, Mandrel; C, Fixed Flange; D, Loose Flange; E, Nut to screw against Loose Flange.

FIG. 8.

also in making hardware and cutlery as well as in the manufacture of plows, safes, stoves, agricultural implements and small machinery of every description.



SIDE VIEW. FIG. 9.

STEAM PACKING.

This article being a compound and fibrous material is eminently adapted for packing pistons, stuffing boxes and for the various parts of steam engines that require packing. It is supplied in sheets, square and round strips, and the fibres are so arranged in the compound as to give the greatest possible amount of durability and relief from friction.

ENLARGING AND DIMINISHING OF DRAWINGS AND PICTURES.

The property of vulcanized caoutchouc to expand and contract uniformly in every direction is taken advantage of for enlarging and diminishing the size of plans and other graphical representations, without making a new drawing on a desired scale. This is accomplished by stretching a plate of vulcanized caoutchouc in a frame, which is provided with suitably arranged screws for making the bars or rails farther apart and uniformly. A few parallel lines intersecting each other drawn beforehand on the plate enable to match and regulate the process of stretching accordingly.

If the drawing is to be enlarged, then it must be transferred on the caoutchouc plate before the same is stretched. If the drawing is to be reduced, then it must

be transferred on the plate after stretching. In retransferring to the stone, the plate remains stretched in case of enlarging, but is taken off the frame, when the drawing must be reduced.

CAOUTCHOUC LEATHER.

Small pieces of caoutchouc waste, of which there is such a large quantity in rubber factories, are dissolved or at least are allowed to swell up considerably in purified petroleum. To this half fluid mass is added any kind of fibrous substances, such as hemp, flax, jute, etc. The incorporation is done by stirring, and then the dough is placed on the table, where some more of those substances are worked into it by kneading. After that the mass is transferred to rollers, where the incorporation is continued, until a suitable degree of solidity is imparted to it. Bands, which are obtained by this process, must be refolded a number of times, and let pass through the rollers, as the fibres become in this way piled in every direction, forming thus a kind of felt. This increases the solidity and tenacity of the substance, which turns to be a splendid substitute for the genuine leather in all those cases where elasticity is not of prime importance.

SURGICAL APPLIANCES.

Nursing Bottles, Breast Pumps, Syringes or Injection Bottles, Air Beds or Mattresses, Invalid Cushions, Bath Tubs, Etc., Etc.

These articles are made in the same way as the articles of wearing appliances, except where irregular shapes and forms are wanted, as in the case of bottles, balls, cups, etc. In such instances they must be made in moulds, and the rubber after having been prepared by mixing and otherwise, as in the other operations, must be pressed into moulds.

CAOUTCHOUC SPONGES.

A thickly fluid solution of caoutchouc in benzol, chloroform or bisulphide of carbon is placed in a high vessel of tin of a prismatic form, and is then heated to above the boiling point of the solvents. This makes the mass more tenacious and thicker in consequence of the evaporation of the solvent ; the steam bubbles find it more difficult to break their way through it, and the mass behind remains porous and full of holes. By using caoutchouc dough and heating it very slowly, sponges are obtained, which have very fine pores, and surpass by their softness the finest bathing sponges. The finished product is then vulcanized by plunging it in a solution of chloride of sulphur.

DEODORIZATION OF INDIA RUBBER GOODS.

The odor emanating from articles made of vulcanized caoutchouc, being very repugnant to some persons, it is a matter of great importance to the manufacturers to remove this objection to the use of their products. The method employed to accomplish this consists either in exposing the articles to a constant high temperature, or they are treated with animal charcoal. Heat drives out the unpleasant smell, but requires too much time, and for this reason animal charcoal, which possesses the property of absorbing odors in a high degree, is more preferable. Steam also is much more effective and more economical than direct heating of objects in a special oven. Frequently the two methods are combined, as for instance in case of India Rubber sponges, which are wrapped up in tissue paper, and being placed in a vessel filled with powdered animal charcoal, are put in a warm place, where they must, however, remain a few weeks before they entirely lose all odor.

GUTTA PERCHA.

Gutta Percha is the dried milky juice of a plant, and is extensively used in all rubber factories, by being worked in connection with caoutchouc, or separately for special purposes, for which it is better adapted than any other material.

The plant yielding this milky juice is the *Inosandra Gutta*, and is an immense tree, reaching a height of 80 feet and 6½ feet in diameter. East India is the country where it grows. While the milky juice of the caoutchouc trees remains fluid for a long time, that of gutta percha trees congeals within a few minutes after it has been tapped. When exposed to the air gutta percha undergoes a process of oxydation, becomes heavier and resinous but loses its hardness, and can be dissolved in alcohol. At an ordinary temperature it has no more elasticity than wood or leather, but its pliability increases when subject to heat, and it melts at 248° F. It has a fibrous structure, and may be easily stretched in the direction of its fibres, but ruptures in any other direction.

USE OF GUTTA PERCHA IN SURGERY.

On account of its greater plasticity as compared to caoutchouc, gutta percha occupies a very prominent place among the substances from which various surgical apparatuses and implements are made. Besides that, dissolved in chloroform, it is applied to external wounds and bruises, and is superior to colladium, because it is less brittle and does not irritate the wound so much as the latter does. For dentistry gutta percha is of great service, and without exaggeration, it may be affirmed, that it owes to this substance its present development. It is namely used for making plates for artificial sets of teeth. Having dissolved gutta percha in chloroform, the dentist must filter it and submit it to a process of distillation, before he obtains a mass of desired purity and plasticity, which will easily assume the required form, and at the same time remain hard and tasteless under the temperature of the mouth, behaving itself perfectly indifferent to the chemical action of whatever it comes in contact with.

There is quite a variety of vulcanizing apparatuses, each constructed to satisfy some special requirements the articles to be vulcanized impose upon it. The simplest and the handiest among them is unquestionably that which is designed for the use of dentists. It consists of two cylindrical vessels, one of which serves as a boiler and the other as an oven for burning. This last one is made with a double bottom and sides, so as to

leave space between for the steam, admitted from the boiler, to circulate all around the inside cylinder, in which are put the articles to be burned. A spirit lamp under the boiler produces the steam and another one, under the burning oven, superheats it. The boiler is provided with a water gauge and an inlet opening for feed water. The burning oven has a safety valve communicating with the intermediate steam space, and is usually set so as to blow off when the pressure goes beyond one atmosphere.

COATING OF WIRES.

Being a perfect non-conductor of electricity, gutta-percha is employed, in preference to any other substance, for insulating telegraph and other lines which transmit electricity. It also serves as an absolute protection against rust, by excluding air. A coat of an ordinary solution of gutta percha allowed to dry upon the wire is amply sufficient in those cases, where the wire is not subject to heavy wear or liable to outside injuries. But the electric light wire, cables, etc., require a much thicker coating, in order to insure a perfectly continuous covering and prevent the possibility of the smallest crack, as it would destroy the insulation, admit sea water and air. This is done by pressing gutta percha, which must be already softened by heat, through an opening discharging it into a cylindrical tube, of a diameter larger than the wire to be coated by the desired thickness of the coating. As the wire comes out covered, a stream of water is applied to cool it, before it is wound upon a drum.

HARD RUBBER.

For the past few years the application of hard rubber became extensive and especially for ornamental purposes such as Ladies' medallions, Bracelets, Scarf and Hair pins, Buttons, Earrings, Combs, and for many other similar articles. For making hard rubber the same materials are employed as for vulcanite, but differ in their proportions and treatment. The hardness and elasticity of hard rubber principally depend on the quantity of sulphur, which has been added to the caoutchouc. Frequently the amount of the former equals one half of the weight of the latter. The greater amount of the admixtures necessitates the keeping of the mass between the kneading-rollers for a long time, until a perfectly homogeneous compound has been formed. The dough obtained is not as soft as that of unburned vulcanite, but nevertheless it can be pressed into moulds and rolled into sheets in the same manner as it is done with vulcanite. But the burning of hard rubber is a much more troublesome operation than that of vulcanite, as it must be gone over several times before the objects subjected to burning can pass for finished goods. This is due to the property of hard rubber to suffer contraction in course of burning and to show cracks and holes, so that the objects must be taken out, repaired and put back again in the oven. By the application of heat it can be bent into any required form, pressure being applied at the same time. The

polish of which this substance is so acceptable renders it equal to Ebony.

The manufacture of artificial ivory, known under the name of Ebonite, principally depends upon the process of bleaching the caoutchouc. The difficulty of decolorizing caoutchouc lies in this, that the bleaching agents tried and recommended appear to produce a chemical change in it, so that the bleached product loses more or less of the properties of caoutchouc. The method consists in letting the mass swell in a solvent, and to introduce chlorine gas into the swelled mass. For solvents are used chloroform, bisulphide of carbon, benzol, turpentine, and rectified petroleum. Although considerably decolorized by these agents, caoutchouc still retains a brownish-yellow color, so that it is necessary to use various admixtures and pigments in order to impart to it the whiteness of ivory, of which it must be an imitation.

As the admixture of pigments or the incorporating of coloring substances through the entire mass injures the property of hard rubber, two other methods are employed, which give to it any desired color, without altering its nature. The first method is known as dusting and consists in dusting with a finely powdered coloring substance the article which has been shaped and to burn with the covering of dust. The second is that of plating or enamelling. The enamel is nothing else than caoutchouc to which the coloring agent was incorporated during the process of vulcanization. After that plates of any desired thickness are made of it in the usual manner, and they constitute the enamel. The rubber

plates which have to be enamelled are covered on one or both sides with enamel plated and passed through the rollers, and thus become colored on the outside, while the inner mass remains unaffected by pigment.

HARD RUBBER LACQUER.

When applied to wood or metal, it forms a brownish-yellow to black coating, which strongly resists atmospheric influences, and is well adapted for varnishing machines erected in the open air. It is made out of waste and broken articles, occurring in the manufacture of hard rubber. The pieces of hard rubber are melted in an iron pot and must be constantly stirred to prevent it from burning. When thoroughly melted, the mass is poured in a thin stream on iron plates, where it congeals to a brittle plate. After being broken into small pieces it is put in a bottle and dissolved with rectified petroleum or benzol. The quantity of solvent added must be sufficient to produce a fluid, which can be easily applied with a brush. The fluid must be allowed to stand for a considerable time before using it, in order to give a chance to foreign substances, generally contained in the rubber, to settle to the bottom.

CAOUTCHOUC ROLLERS FOR MARBLING AND ENGRAVING.

The superiority of India Rubber Stamps over metal and wooden ones is due to the elasticity of caoutchouc, which enables to stamp with distinctness on hard surfaces, while metallic stamps do not give a good imprint on hard stuff. The same property of rubber is taken advantage of in making stereotype plates of it, instead of metal, and not only pages of printed matter can be transferred on it, but also drawings and pictures. The most interesting and extensive application of this method is found in giving to plane and curved surfaces on wood, leather, paper, etc., the appearance of any other substance, or in producing imitations.

This is done by designing or by transferring on a vulcanized caoutchouc plate the figures and shade lines, corresponding to marble, oak, or of anything else, and in making from this plate a roller similar to what printers are using. Covered with the proper pigment or color, this roller transfers the design to the surface it is made to pass over.